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MARINE INDUSTRY STANDARDS
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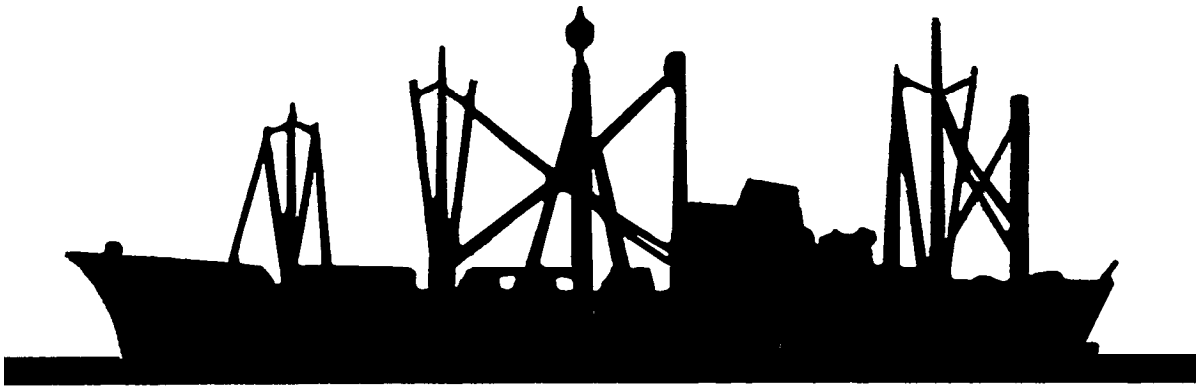

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

IREAPS

A NATIONAL COALITION FOR THE SHIPBUILDING TECHNOLOGY PROGRAM

F. William Helming III
Manager CAD/CAM Navy Department
Softech Inc
Waltham, Massachusetts

ABSTRACT

An investigation of an approach to a U.S. Navy sponsored shipbuilding technology program is discussed. An approach is recommended, and a detailed project plan for a shipbuilding technology program is proposed.

Section 1

INTRODUCTION

The U.S. Navy has announced its intention to initiate a major program for the enhancement of shipbuilding technology in the United States. The objectives of this program are to improve the quality, cost, and construction time for future U.S. Naval Ships, and to strengthen this country's shipbuilding industrial base. This motivation is heightened by the Administration% plans to increase the Navy's fleet to 600 ships by 1988. This program is currently budgeted as a six-year, $80M effort, though its format has not been defined.

Previously the Naval Sea Systems Command had contracted with SofTech, Inc. to assess Air Force initiatives in manufacturing technology with respect to Navy needs. Both the Navy and the Air Force have established programs to promote computer-aided manufacturing which have differed markedly in budget, in approach, and in industry involvement and acceptance. SofTech was directed to consider the applicability of the ICAM (Integrated Computer-Aided Manufacturing) Program approach to a Navy STP (Ship building Technology) Program.

This paper recommends an approach to the planning, management, and integration portion of a national, participative Shipbuilding Technology Program (STP). These recommendations are SofTech's, and are not to be construed as government policy. They are based on SofTech's initial analysis, and on pertinent comments received from individuals in the Navy and the shipbuilding industry.

Section 2

THE ORGANIZATION: A NATIONAL COALITION

Two primary conclusions have emerged from discussion and analysis of the issues regarding the planning and management of a program of the scope of STP. First, such an undertaking cannot succeed without the acceptance and direct involvement of the Shipbuilding industry. The industry must participate in needs definition, planning, focus, and implementation of the Shipbuilding Technology Program. The immediate corollary to this is that participation of all major segments of the industry can be secured though utilization of existing standing committees and forums. These groups include the many panels of the Ship Production Committee of SNAME, the IREAPS organization, the Maritime Administration's National Ship Research Program, and others.

The second major conclusion drawn with respect to developing a format for STP is that the organizational and technical concepts followed by the ICAM program represent an excellent model. This is true because the coalition concept has proven useful in effecting direct participation of diverse industry groups with the government, and because past technical results have been well received and implemented by government and industry participants.

For the above reasons, a national shipbuilding industry coalition is recommended as the most appropriate organizational concept for the planning and integration of the STP. The schematic of Figure 1 shows the relationships among the various players.

STP Coalition members have the following recommended functional roles. A Navy project office would be established to provide guidance and oversight for the planning and integration coalition activities, and to participate in the planning process. The project office would receive advice from Shipbuilding industry groups such as the Ship Production Committee of SNAME and the Shipbuilder's Council of America, and would maintain liaison with major DOD-level activities such as the Manufacturing Technology Advisory Group.

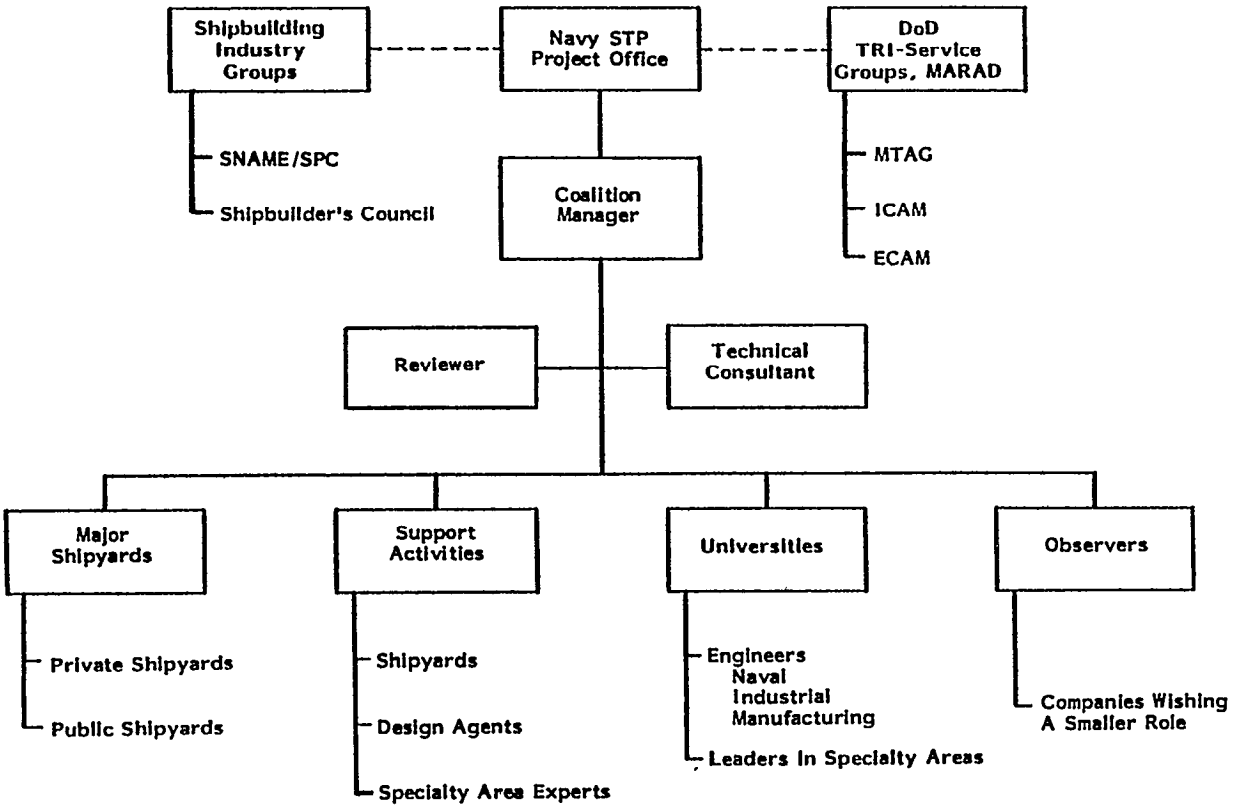

Figure 1. Recommended STP Planning and Integration Coalition

The Coalition Manager would serve as a prime contractor for the national coalition, and would have contractual responsibility for program deliverables (i.e., STP Master Plan). The Coalition Manager is essentially the systems engineer for the planning effort and would serve as the project consultant in the application and integration of CAM technology. This role also would include all required training in analytical techniques and integration methods.

The Technical Consultant would provide a broad baseline of shipbuilding knowledge, from both government and commercial perspectives. The TC would lead shipbuilding technology analyses to identify candidate STP projects, and would develop return on investment analyses for these.

The Reviewer would focus the planning efforts of the coalition by reviewing and approving the STP Master Plan and the priorities for candidate STP projects. This role, which might possibly be filled by a standing organization such as IREAPS or the Ship Production Committee, would also include steering the evolution of the planning and integration coalition itself.

Major Shipyards would participate by recommending projects for consideration, leading designated shipbuilding process analyses, and by reviewing similar analyses prepared by other yards. The yards would recommend priorities for STP projects, and provide data for ROI analyses.

Support Activities which would include design agents, specialty consultants, and possibly additional shipyards, would provide specialty area expertise or concentrate on the analysis of identified STP projects. Universities would provide future perspective to the coalition's activities, and the Observer role will be maintained for those organizations desiring a lesser role but wishing to remain informed.

The primary goal in selection of coalition members is the inclusion of a sufficiently diverse group so that all shipbuilding areas are covered. Ship builders must be included to ensure that changes considered are practical and feasible. Shipbuilding consultants and ship design agents must be included to provide specialized teqhnical knowledge, objective judgement, and broad industry perspective. Universities and affiliates should be included to provide a future-oriented perspective, and knowledge of advancing state-of-the-art technology.

The impact of each organization on Navy procurements should be evaluated when selecting coalition members. STP must represent both Navy and commercial ship building views, since it is unreasonable to separate one from the other. However, the coalition must show a major involvement in Navy shipbuilding to ensure that STP results will have the desired effect on future Navy costs and readiness, and on industry responsiveness to Navy needs.

A final, key attribute for coalition membership is the attitude of organizations and individuals toward change. A proven, progressive attitude toward change is essential to STP Success, evidenced both by a willingness to share company data (on a controlled basis), and a willingness-to work toward the good of the industry, not only individual company interests.

Section 3

THE APPROACH: SYSTEMS ENGINEERING

The relationship of the STP planning and integration project, which this paper describes, to the total STP program is shown in Figure 2. It is recommended that the planning and integration effort be maintained throughout the life of the STP, so that the STP Master Plan can serve as the planning "road map" and baseline for integration of the ongoing specific STP projects.

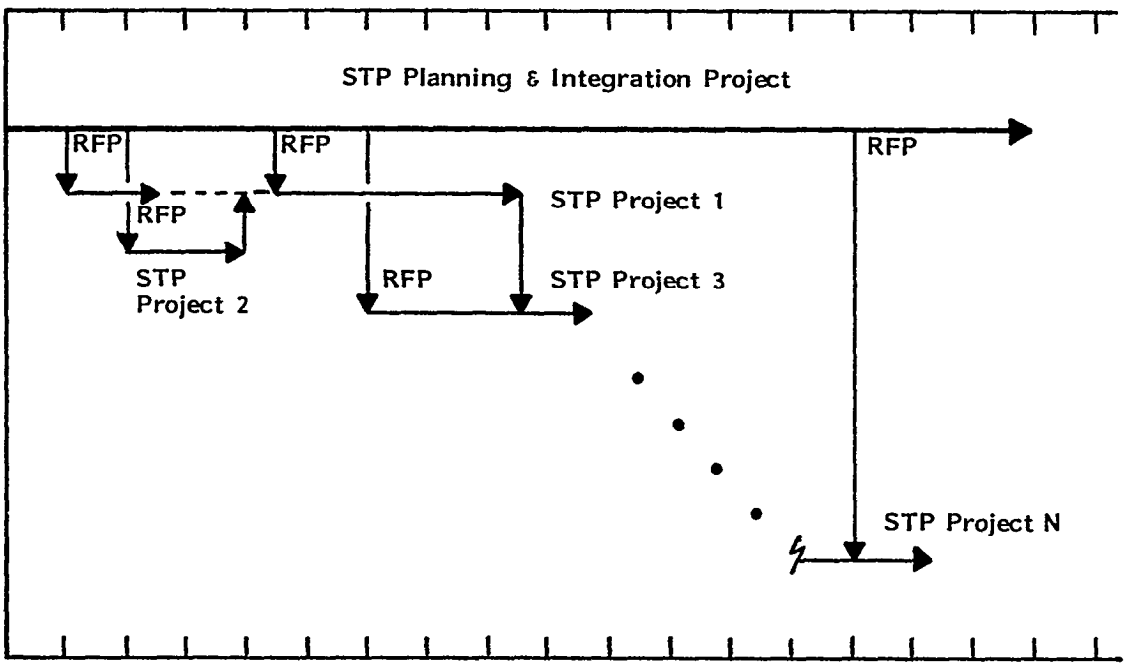

Figure 2. Recommended Shipbuilding Technology Program

The above figure highlights the key benefit of the technical approach advocated in this paper: integration. The disciplined systems engineering methods described here provide the basis for integrating the development of individual STP projects in such a way that they interact smoothly with each other and with existing systems. It is this integration which will provide the substantial improvements in productivity which are the goal of the Shipbuilding Technology Program.

Figure 3 presents a functional approach to developing the Shipbuilding Technology Program. The STP planning and integration project described in this paper is concerned with Boxes 1 and 2 of this figure.

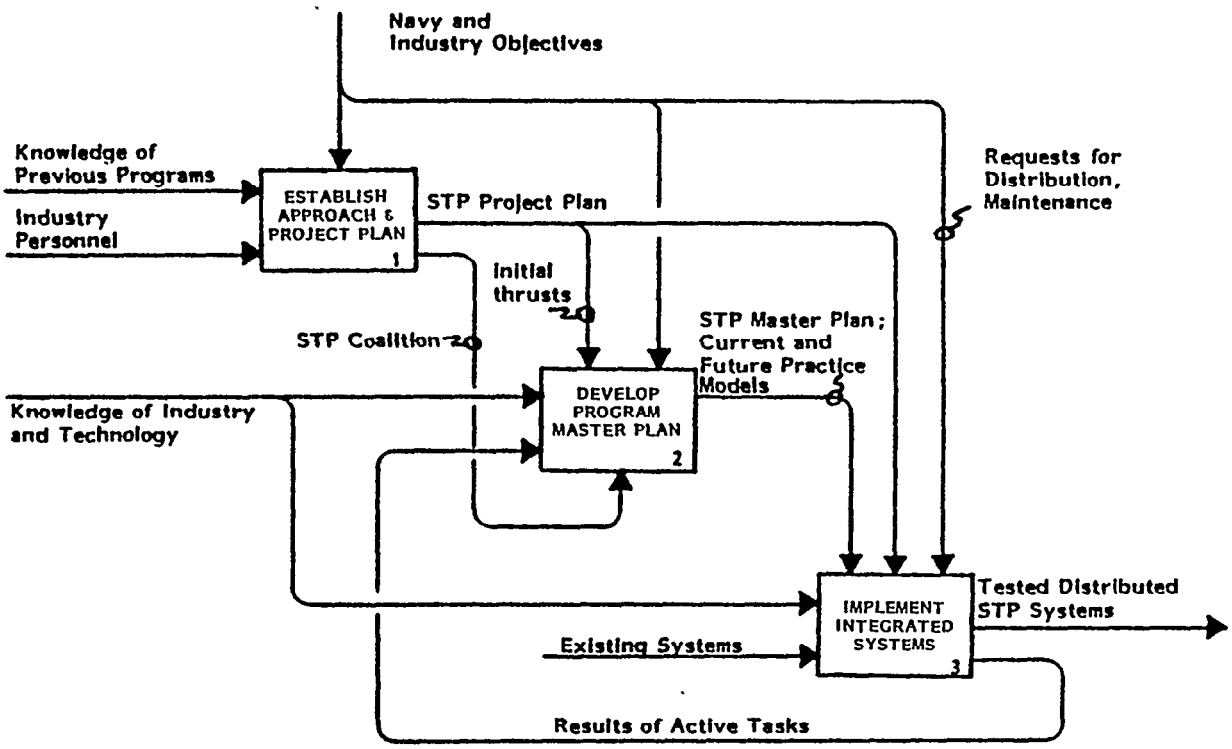

Figure 3. Develop Shipbuilding Technology Program

First, an approach and project plan must be established, to document the scope, approach, organization, and methods for STP planning and integration. This paper summarizes a first cut at a project plan. Key inputs are industry personnel and knowledge of previous programs, such as the Navy's Computer Aided Structural Detailing of Ships (CASDOS), Computer Aided Ship Design and Construction (CASDAC), and MarAd's Research and Engineering for Automation and Productivity in Shipbuilding (REAPS). This activity, driven by both Navy and industry needs, will result in an STP Project Plan, complete with budgets and schedules, and a defined (and contracted) national STP industry coalition.

The purpose of the STP Coalition is the creation and maintenance of the Master Plan for STP. The creation of the Master Plan will be guided by Navy and industry needs, as well as near-term, high-payoff initial thrusts identified during early project planning. Starting points for these initial thrusts include ongoing IREAPS projects, U.S. Navy Advanced Technology and Manufacturing Technology projects, as well as each yard's existing backlog of modernization projects. Knowledge of the shipbuilding industry and of available technology will be the primary input to this planning. Once the STP has been established, continuous inputs regarding active tasks will also impact planning. The major output of this phase will be models of current and future shipbuilding practice, and the STP Master Plan. The Master Plan will define and sequence the tasks required to move the shipbuilding industry from current to future shipbuilding practice. The Navy and industry will work together to determine the scope and priority of all STP modernization projects.

The final phase of the Shipbuildng Technology Program will be the implementation of the integrated STP systems, in accordance with the STP Project Plan and the STP Master Plan. The STP systems will be tested thoroughly, and distributed in response to industry requests. The implementation work will be performed by members of the shipbuilding industry. System development may be accomplished by small coalitions, and these efforts will be distinct from those of the STP planning coalition. Existing systems and proven technology will be utilized where possible to minimize technical risk. These systems will be applied in concert with the industrial knowledge base to develop and integrate fully functional STP systems into ongoing shipyard operations.

Further detail is provided here concerning the development of the STP Master Plan (Figure 4). Guided by the STP Project Plan, the current industrial practice of U.S. Shipyards would be documented, based on the knowledge of the industry and pertaining technology possessed by the STP coalition.

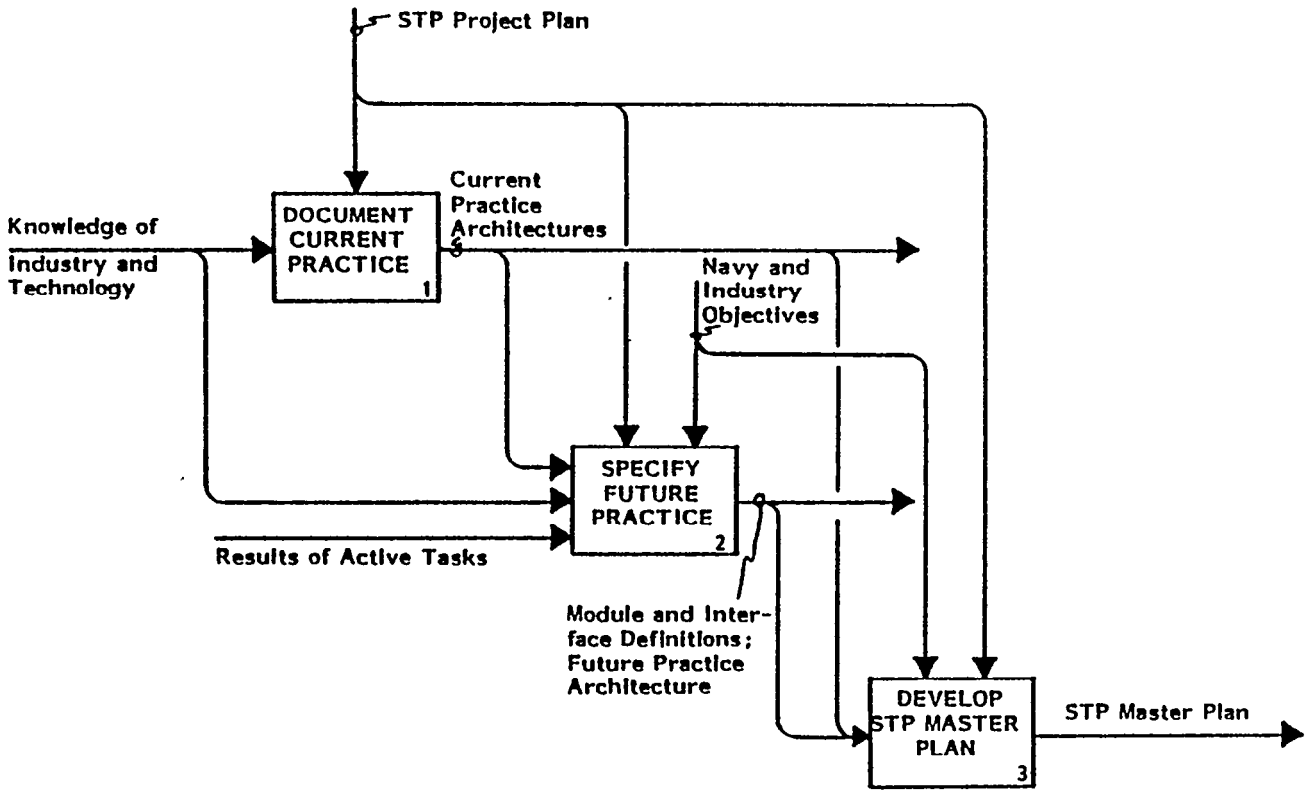

Figure 4. Develop Program Master Plan

The current shipbuilding practice model and the coalition's knowledge base would then be utilized to develop a model documenting future shipbuilding practice. This procedure would be guided by the STP Project Plan and defined Navy and industry objectives. The products of this procedure will be the future shipbuilding practice model, and interface definitions for proposed STP systems.

The information produced during these two activities would be the primary input to developing the STP Master Plan. This plan defines a roadmap displaying the priority and interdependencies of all STP systems and projects. The priority of these projects is determined jointly by the Navy and the shipbuilding industry, with the advice of the Reviewer.

The models developed in the course of the first two activities shown on Figure 4 will be built according the the strategy shown in Figure 5.

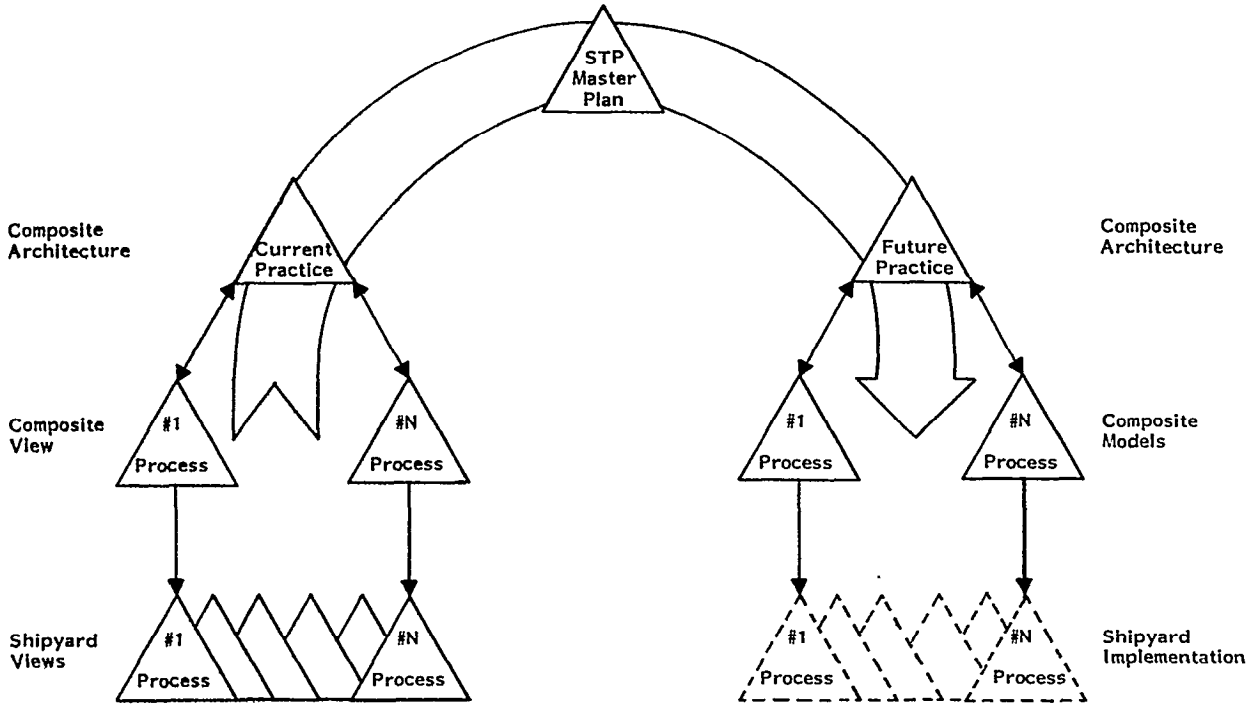

Figure 5. Models Used for STP Master Planning

The STP effort will identify potential improvements by building a model of current shipbuilding practice and model of possible future practice, then defining and sequencing projects to move from current to future practice.

The model of ship design and construction should be developed on a three tier structure. One begins first with a "current practice" shipyard view. This model of construction is peculiar to each shipbuilder and construction process. For each process, a single Major Shipyard should be responsible for developing its company's "Current Practice" Shipyard View; this Shipyard and the

Coalition Manager should then lead two to three other Major Shipyards in augmenting this model with their shipyard viewpoints. An aggregate representation of all that is required to design, engineer, construct, and maintain that shipbuilding process would emerge; this aggregate representation would be the process's "Current Practice" Composite View.

An important consideration in the development of composite models is that of security of data viewed as proprietary by coalition members. It is recommended that the following security system be required in all coalition' subcontracts. All information submitted to the Coalition Manager must be stamped with security level, indicating that it may be disclosed only to the Coalition Manager, only to the Manager and the government, or to all coalition members.

The coalition would develop "Current Practice"'Shipyard and Composite Views for each of the many shipbuilding processes. Once all selected Composite Views are developed, a careful analysis would be made of their underlying common structure. This structure represents the third tier of ship design and construction, and is defined via a "Current Practice" Composite Architecture. The Composite Architecture describes all of the uderlying of Common construction functions found in the process models. Making use of the "Current Practice" Composite Architecture, and by analyzing emerging technologies and planned improvvements, a "Future Practice" view of ship design and construction would be developed. This future would be represented by both individual "Future Practice" process models, and by a common "Future Practice" Composite Architecture, as shown.

The time frame for implementation of the STP planning and integration effort is crucial, so that needed productivity improvements can be realized as soon as possible. The integration of ongoing and planned manufacturing technology efforts, as well as the identification of new STP projects should, if begun immediately, significantly enhance the industry's capabilities with respect to the Navy's 600 ship requirement.

The development of the STP Master Plan can and should begin immediately. Within 6 to 12 months, tecchnical modernization projects could begin. These projects, which are yard and/or procurement specific, feature generally well-defined problems, speedy implementation, and short payback periods. More generic technology applications, which might apply to more **than** one facility and require cooperative planning and execution, could be undertaken in one to three years. Finally, support technology and systems, integrated across the industry, could get under way in **the** four to six year time frame.

Section **4**

TOOLS AND TECHNIQUES

Because **the** approach rcommended here for **the** planning and integration of **the** Shipbuilding Technology Program represents a systems analysis task of almost unprecedented size, special tools and techniques are required to assist in planning, analysis, and communication. A rigorous language is required, to provide for unambiguous communication among **the** many diverse groups who will perform on STP. A method of structured analysis which provides a means of controlled decomposition to permit attacking problems in parallel as opposed to in series, is required. Finally, a proven integration methodology is required, to provide for clean interfaces and clear divisions among sub-problems **so that** sub-problem solutions can be assembled into working systems.

To meet **these** needs, SofTech has recommended **the** use of the ICAM Definition ($IDEF_0$) Language. $IDEF_0$ is in **the** Public Domain, and complete literature and courses **have** been developed, and are available. Additionally, the following organizations have adopted $IDEF_0$ as their standard language for use in describing and analyzing CADCAM systems:

- Air Force Manufacturing Technology, ICAM
- Army ECAM
- Society of Manufacturing Engineers
- Computer-Aided Manufacturing-International
- DoD Manufacturing Technology Advisory Group (Recommended)

Section 5

CONCLUSIONS AND RECOMMENDATIONS

These conclusions are based upon discussions concerning the approach to the planning and integration of the Shipbuilding Technology Program presented here. These discussions have been held with individuals from the shipbuilding industry and from the Navy.

With respect to scope, it is recommended that STP address the entire spectrum of shipbuilding technology, as opposed to focusing on one specific technology area, such as CADCAM technology.

It is anticipated that the opportunities for productivity improvement will exceed the limits of available resources. Resource limitations will be realized in capital availability, capital equipment availability, and, most critically, in the availability of capable, knowledgeable personnel to implement and use the projected systems.

The near-term emphasis of the Shipbuilding Technology Program should be placed on the selection and implementation of known critical technology areas existing in shipyards today. This work could be planned and executed in parallel with the documentation of current practice, in order to maintain the long-term benefits of integration. Technology areas for this immediate action might be selected from sources such as ongoing IREAPS projects, USN Advanced Technology and Manufacturing Technology projects, and the Marine Equipment Leasing, Inc. Technology Survey of U.S. Shipyards. This type of timely and definitive Navy action would serve to establish valuable credibility with the industry, and thus solidify industry support for STP.

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INTRODUCTION

WHAT	**IMPROVE PRODUCTIVITY**
WHY	**BETTER SHIPS FASTER AND CHEAPER**
WHERE	**U.S. SHIPBUILDING INDUSTRY**
HOW	**INTEGRATED TECHNOLOGY**
WHO	**NATIONAL COALITION**
WHEN	**IMMEDIATELY**
HOW MUCH	**SCOPE AND RESOURCES**

SHIPBUILDING TECHNOLOGY PROGRAM

WHAT: IMPROVE PRODUCTIVITY

- IMPROVED PROCESSES, METHODS, EQUIPMENT
- MAXIMUM DISSEMINATION OF RESULTS
- STIMULATE INDUSTRY INVESTMENT

WHY: BETTER SHIPS FASTER AND CHEAPER

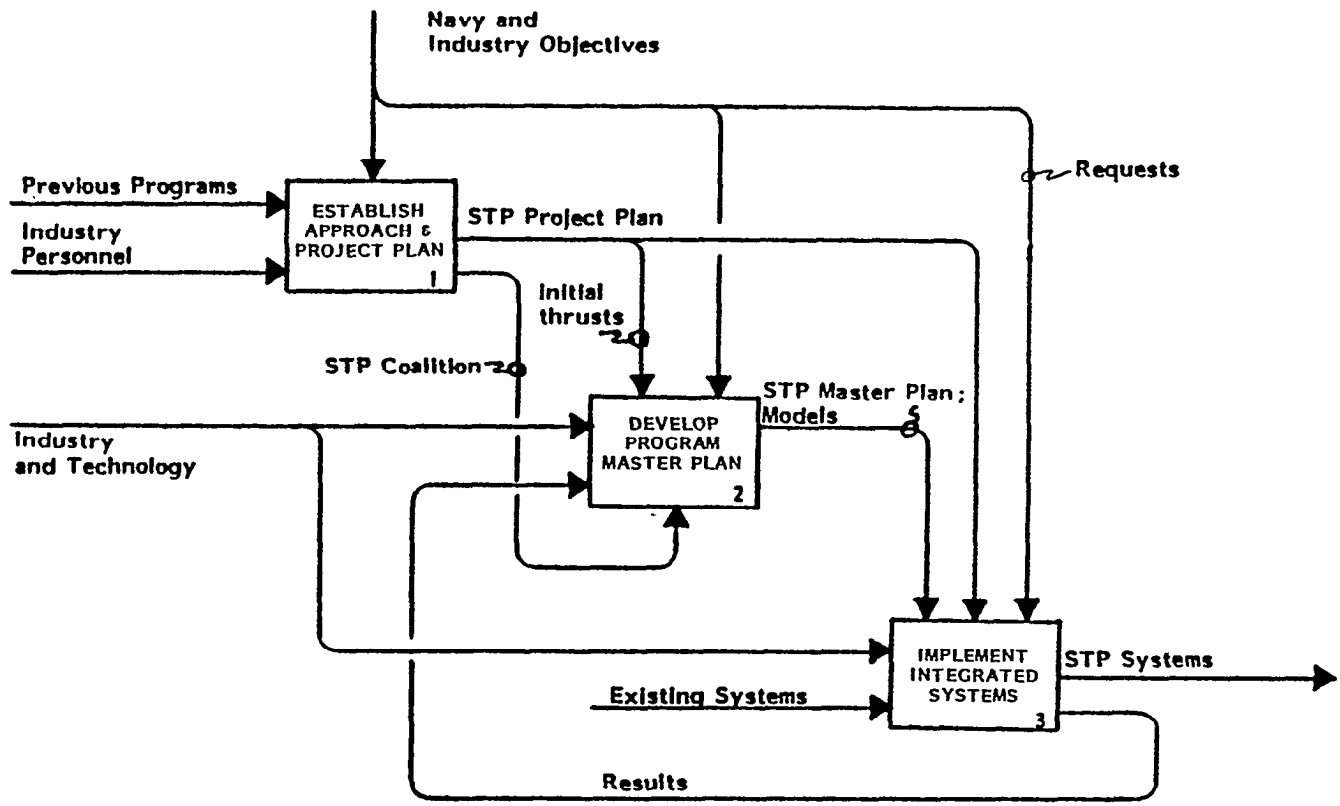
- REDUCE ACQUISITION TIME
- IMPROVE AS-BUILT QUALITY
- REDUCE LIFE-CYCLE COSTS

WHERE: U.S. SHIPBUILDING INDUSTRY

	SECTOR	
FUNCTION	PRIVATE	PUBLIC
DESIGN	√	√
CONSTRUCTION	√	
MAINTENANCE	√	√
REPAIR & OVERHAUL	√	√

HOW: INFUSION OF INTEGRATED TECHNOLOGY

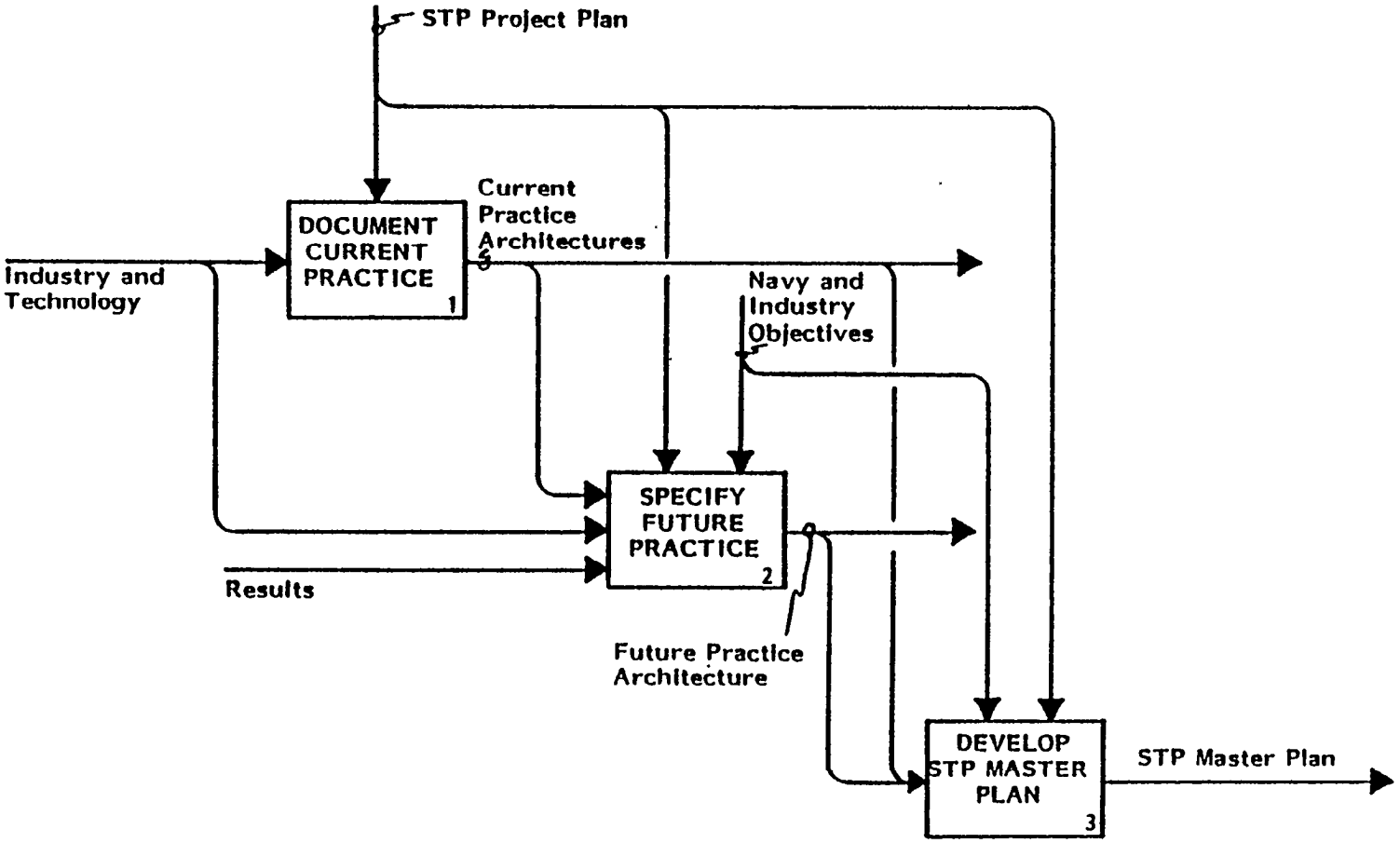
ORGANIZATIONAL APPROACH	NATIONAL COALITION
TECHNICAL APPROACH	SYSTEMS ENGINEERING
TOOLS AND TECHNIQUES	FUNCTIONAL ANALYSIS



DEVELOP SHIPBUILDING TECHNOLOGY PROGRAM

SHIPBUILDING TECHNOLOGY PROGRAM

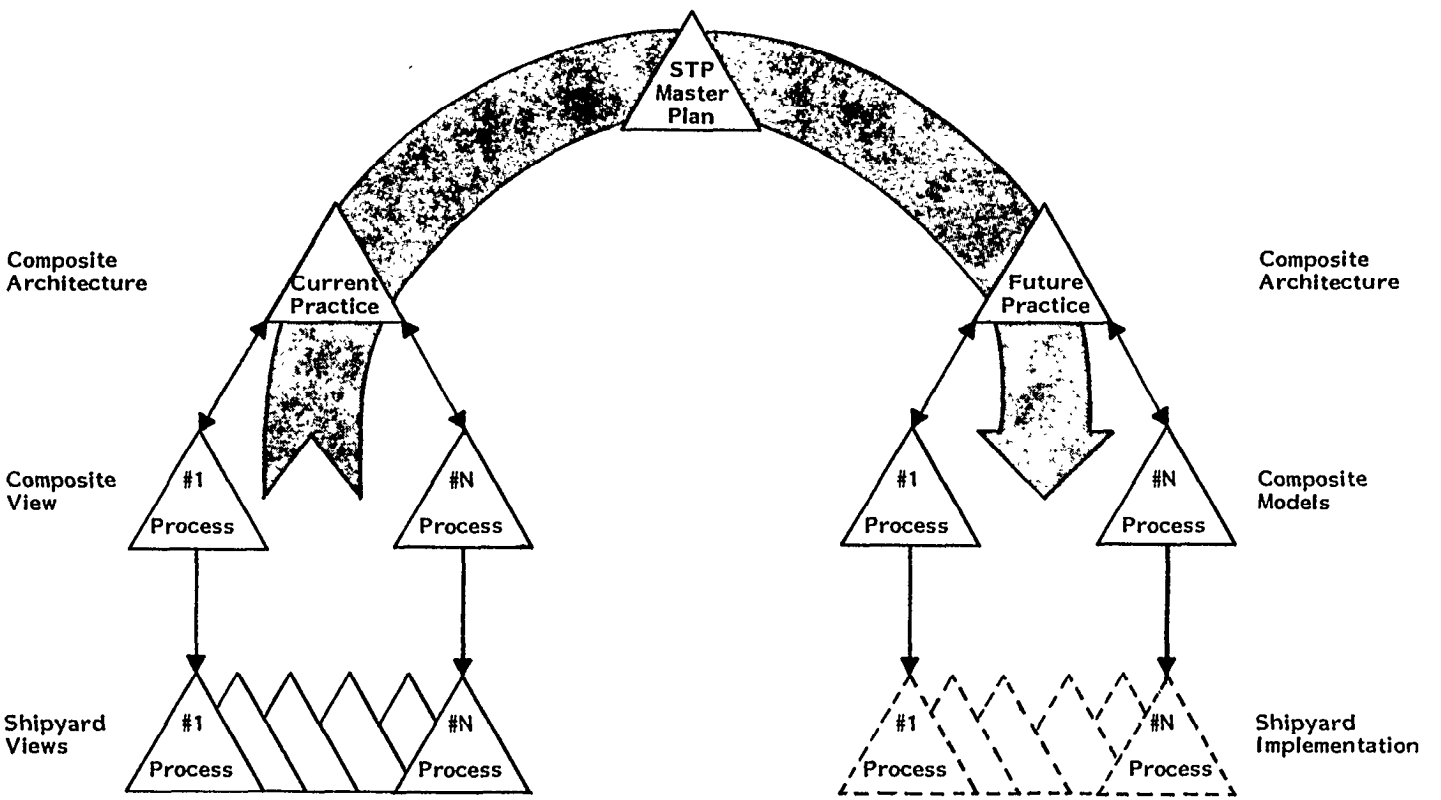
HOW: INFUSION OF INTEGRATED TECHNOLOGY



DEVELOP PROGRAM MASTER PLAN

SHIPBUILDING TECHNOLOGY PROGRAM

HOW: INFUSION OF INTEGRATED TECHNOLOGY



MODELS USED IN STP MASTER PLANNING

HOW: INFUSION OF INTEGRATED TECHNOLOGY

MASTER PLAN OUTLINE

- MASTER SCHEDULE
- GUIDELINES AND STANDARDS
- FUTURE PROJECTS
  - PRIORITY
  - INTERDEPENDENCE
- INDIVIDUAL PROJECT DESCRIPTIONS

TOOLS AND TECHNIQUES	
RIGOROUS LANGUAGE	UNAMBIGUOUS COMMUNICATION
STRUCTURED ANALYSIS	CONTROLLED DECOMPOSITION
INTEGRATION METHODOLOGY	CLEAN INTERFACES

$IDEF_0$

- PUBLIC DOMAIN
- COURSES, LITERATURE
- STANDARD FOR

  AF MAN/TECH, ICAM

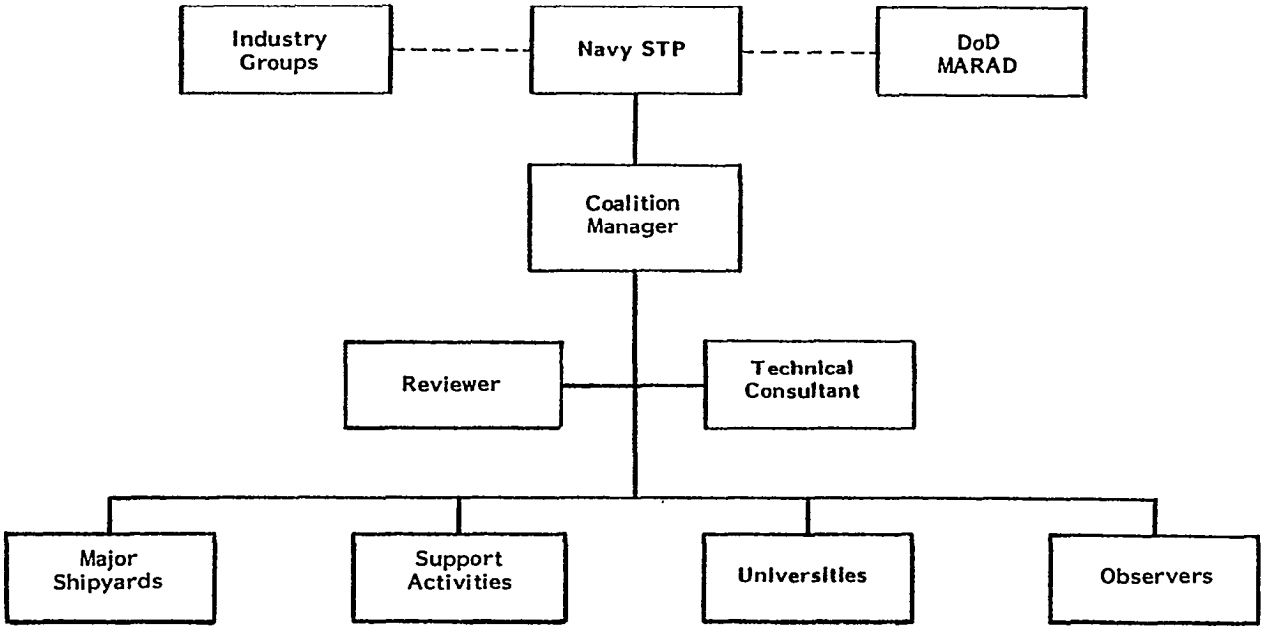
  ARMY ECAM

  DoD MTAG

  SME

  CAM-I

WHO: NATIONAL COALITION



COALITION ROLES	
COALITION MANAGER	STP MASTER PLAN
TECHNICAL CONSULTANT	BROAD SHIPBUILDING KNOWLEDGE
REVIEWER	SET PRIORITIES
MAJOR SHIPYARDS	DEFINE PROCESSES
SUPPORT ACTIVITIES	SPECIAL EXPERTISE
UNIVERSITIES	FUTURE PERSPECTIVE
OBSERVERS	FORUM

WHO: NATIONAL COALITION

MEMBERSHIP CRITERIA

- KNOWLEDGE BASE
- INDUSTRY-WIDE PERSPECTIVE
- SPECIAL VIEWPOINTS
- IMPACT ON NAVY PROCUREMENTS
- ATTITUDE: CHANGE; SHARE DATA

WHEN: IMMEDIATELY

TIME FRAME

NOW	• STP MASTER PLAN
6-12 mos.	• TECHNICAL MODERNIZATION PROJECTS
1-3 yrs.	• GENERIC TECHNOLOGY APPLICATIONS
4-6 yrs.	• SUPPORT TECHNOLOGY AND SYSTEMS

HOW MUCH: SCOPE AND RESOURCES

RESOURCE LIMITATIONS	
GOVERNMENT FUNDING	PAY BACK OPPORTUNITIES
CAPITAL	PAY BACK OPPORTUNITIES
CAPITAL EQUIPMENT	LEAD TIMES
PERSONNEL	SOURCES, TRAINING

SUMMATION

SHIPBUILDING TECHNOLOGY PROGRAM

WHAT: IMPROVE PRODUCTIVITY

WHY: BETTER SHIPS FASTER AND CHEAPER

WHERE: SHIPBUILDING INDUSTRY

HOW: INTEGRATED TECHNOLOGY

WHO: NATIONAL COALITION

WHEN: IMMEDIATELY

HOW MUCH: PACED BY RESOURCES

SUMMATION

STP MASTER PLAN

WHAT :	ROAD MAP FOR STP
WHY:	BASELINE FOR INTEGRATION
WHERE :	U.S. SHIPBUILDING INDUSTRY
HOW:	SYSTEMS ENGINEERING
WHO:	NATIONAL COALITION
WHEN:	IMMEDIATELY
HOW MUCH:	NEAR TERM VS. LONG TERM NEEDS

STP PROJECTS

WHAT:	IMPLEMENT PROJECTS
WHY:	ACCOMPLISH IMPROVEMENTS
WHERE:	• BOARD ROOMS • SHIPYARDS • DESIGN OFFICES
WHO :	• USERS
HOW:	STRUCTURED APPROACH PER MP
WHEN:	TIME-PHASED
HOW MUCH:	CAPITAL LIMITED, PEOPLE LIMITED